March 17, 1942. W. F. CAREY 2,276,761

APPARATUS FOR THE CLASSIFICATION OF MATERIAL

Filed Feb. 14, 1938 2 Sheets-Sheet 1

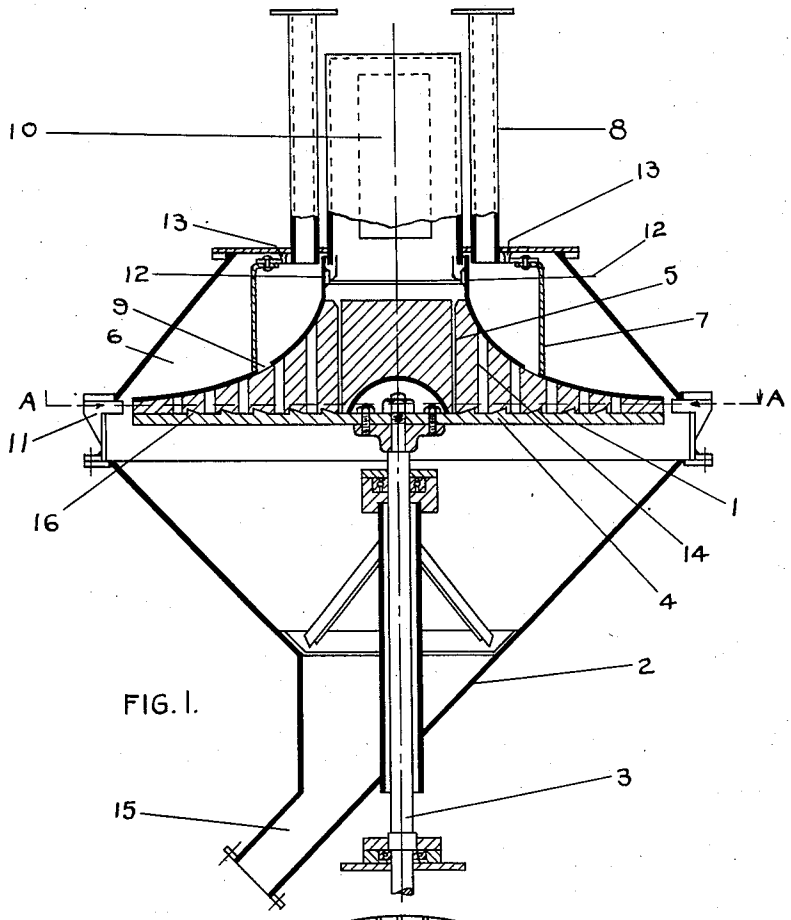


FIG. 1.

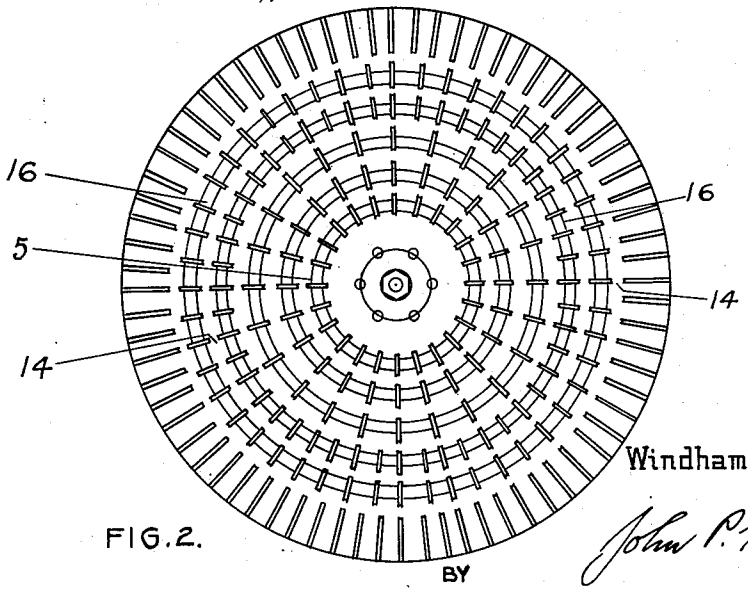


FIG. 2.

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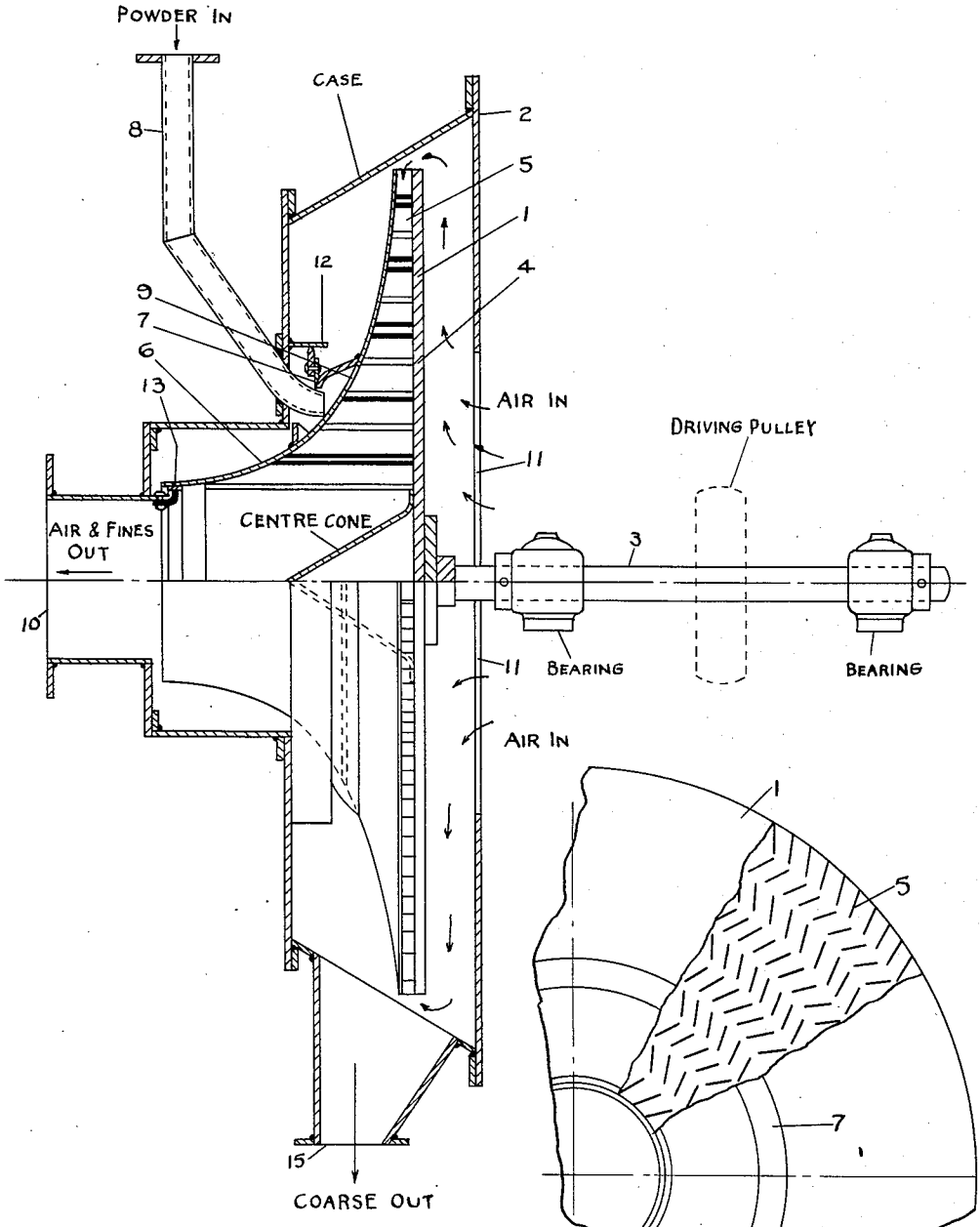


FIG. 3.

FIG. 4.

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APPARATUS FOR THE CLASSIFICATION OF MATERIAL

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Application February 14, 1938, Serial No. 190,479
In Great Britain February 15, 1937

7 Claims. (Cl. 209—144)

This invention relates to the classification of materials into coarse and fine fractions, and more particularly to a centrifugal type of classifier adapted to separate divided substances of different size.

It is already known to classify finely divided or powdered material into coarse and fine fractions by allowing the material to fall freely under the action of gravity in opposition to an upwardly moving stream of gas, whereby the coarse particles continue their descent while the finer particles are carried upwardly with the gas stream. This method, however, has the disadvantage that in view of the small force exerted on the particles, it is not possible to separate a fraction the maximum particle size of which is less than about 100 microns, or, in other words, to obtain a cut at less than 100 microns, without using very cumbersome equipment.

This invention has as an object to devise a method whereby it is possible to obtain satisfactory cuts at as low as say 5 or 10 microns or lower. A further object is to provide a compact apparatus which will operate the said method. Further objects will appear hereinafter.

These objects are accomplished by the following invention.

I have found that I can get satisfactory separation if I subject the powdered material simultaneously to the action of a centrifugal force and to an opposing stream of fluid, the cross-sectional area of the stream of fluid varying from point to point so that the force of the stream varies in such a way that at all points within the area of the centrifugal force the size of particle upon which the centrifugal force and the oppoing stream neutralise each other is always the same.

Thus when the particles are in the neighborhood of the centre of the centrifuge the centrifugal force is small, the cross-section of the opposing stream is therefore made large so that the force of the opposing stream is small, while when the particles are in the neighbourhood of the periphery the centrifugal force is large and the cross-section of the air stream must be cut down so as to get a large force. The size of the cross-section is always so adjusted that at any point in the centrifuge the fine particles will always travel with the stream and the coarse against it, while those particles which are exactly the size at which it has been decided to make the cut will remain stationary at whatever part of the centrifuge they happen to be.

Two forms of apparatus for carrying out the invention will now be described with reference to the accompanying drawings in which Fig. 1 is a vertical cross-section, and Fig. 2 a horizontal cross-section of the rotor along the line A—A of Fig. 1, the upper part of Fig. 3 is a vertical cross-section of a modified form of apparatus in which the rotor is mounted on a horizontal axis while the lower part shows the rotor in elevation and the housing in section, while Fig. 4 is a view of a segment of the rotor, in the modification, seen in elevation with part of the cowl broken away to show the arrangement of the rotor vanes.

The classifier consists essentially of a rotor 1 which is revolved inside the stationary housing 2 by means of a shaft 3. The rotor consists of a circular table 4 upon which a number of plates 5 are mounted radially the plates being surmounted by a cowl 6. The material to be classified is fed to the rotor through the tubes 8 and is directed towards an annular slit 9 in the cowl by a cylindrical member 7 which rotates with the cowl. A suitable fluid such as air is drawn by a suction fan attached to the orifice 10, into the housing through vents 11 and then inwardly between the table and the cowl of the rotor. Suitable seals between the housing and the cowl and the housing and the cylindrical member are provided at 12 and 13 respectively, to prevent escape of the fluid.

The particles to be classified, when they have fallen into the rotor, are subjected to a centrifugal force the magnitude of which is directly proportional to the distance of the particles from the centre of the rotor. The cowl is designed so that the inward radial velocity of the fluid progressively diminishes towards the centre of the rotor table in such a manner that at all points it just balances the centrifugal force acting upon a particle of the size at which a cut is desired. In consequence the particles of the size at which a separation is required describe circles and move neither outwardly nor inwardly. Finer particles move inwardly in spirals and are drawn away with the fluid through the orifice 10. Coarser particles move outwardly in spirals and fall into the boot 15 and there withdrawn. The necessary calculation for the design of the cowl can easily be made from known relations between the size of particles and their free falling speed through a given fluid under the action of a given force. For these calculations the action of gravity can be disregarded since it is small compared with the centrifugal force impressed on the particles by the rotor.

The radial plates 5 are preferably provided

with slots 14 at intervals. Otherwise, the material accumulates against the radial plates and their exposure of the material to the fluid stream is diminished. The material passes through the slots and is again subjected to the action of the fluid in the adjacent compartment. The rotor table is also preferably provided with circular ridges 16 which throw the material upwardly into the fluid stream. Better exposure to the fluid stream and consequently a sharper separation is thereby obtained.

The orifice in the cowl is shown about midway between its inner and outer edges. This position provides an equal opportunity for the fines carried outwardly by the coarse and the coarse carried inwardly by the fines to separate and travel inwardly and outwardly respectively. In practice, however, there is a greater tendency for the coarse particles to mask the fine particles than the reverse, and it is therefore convenient to have the point of feed nearer the inner edge of the cowl.

The modification shown in Figs. 3 and 4 is fundamentally the same and the same reference numerals have been used to designate the corresponding parts. The principal differences are that the rotor is mounted on a horizontal instead of a vertical shaft and the rotor rotates in a vertical plane, for the radial plates 5 there has been substituted vanes arranged in zig-zag fashion as shown at 5 in Fig. 4, and for the cylindrical member 7 has been substituted the annular cowl shaped member 7, and the circular ridges 16 are unnecessary and therefore omitted.

This machine may be used for separating finely divided substances in either granular, powdered or pulverulent state, such as: coal, anhydrite, cement clinker, phosphate, sulphur, iron oxide, and various ores.

This apparatus is more compact and efficient than any that are known to me and gives a more effective separation, i. e. fewer fine particles are to be found among the coarse and fewer coarse particles among the fine, than in previously known apparatus, beside which by varying the velocity of the fluid stream in relation to the speed of the rotor it is possible to get a cut at any desired size of particle.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that I do not limit myself to the specific embodiments thereof except as defined in the appended claims.

I claim:

1. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, walls on said rotor forming passages extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

2. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, walls on said rotor forming passages, said passages being separated by plates which are provided with slots affording intercommunication between the passages, the aforesaid passages extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

3. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, said rotor comprising a circular table upon which a number of plates are mounted radially, said plates being surmounted by a cowl, walls on said rotor forming passages, extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

4. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, said rotor comprising a circular table upon which are circular ridges and a number of plates which plates are mounted radially, said plates being surmounted by a cowl, walls on said rotor forming passages extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped

that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

5. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, said rotor comprising a circular table upon which are circular ridges and a number of plates which plates are mounted radially, said plates being surmounted by a cowl, walls on said rotor forming passages extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means located about midway between the inner and outer edges of the cowl for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

6. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, walls on said rotor forming passages which passages are separated by the aforementioned plates these plates being provided with slots affording intercommunication between the passages, the aforesaid walls extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means located about midway between the inner and outer edges of the cowl for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

7. A device for separating finely divided solids according to size comprising a casing, a rotor within said casing, said rotor consisting of a circular table upon which a number of vanes are mounted in zig-zag fashion, said vanes being surmounted by a cowl, walls on said rotor forming passages extending inwardly from the periphery of said rotor a major portion of the distance to the center thereof, means providing an exit from the center of said rotor, means for rotating said rotor, means for producing a current of air inwardly through said passages and out through said outlet, means for introducing finely divided solid material into said current of air, said walls being so formed as to confine the current of air during its passage from the periphery to the exit, and being so shaped that the cross sectional area of said passages increases from the periphery of said rotor for a major portion of the distance from the periphery to the center thereof at such a rate that the resultant of the centrifugal force and the force of the inwardly flowing current of air will tend to move any given particle only inward throughout the radial extent of said passages or only outwardly throughout the radial extent of said passages, depending on the size and mass of said particle.

WINDHAM FRANCIS CAREY.